SiC & MORE

www.SiCandMore.com No. 90/ Nov2021

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SiC SUPPLY SUFFERS AS DO PRICES



Pictured above is an SiC furnace under power at the Binhe crude plant in China

When any member of the ***SiC & More*** staff receives questions from readers about the price and availability of commodities such as silicon carbide, fused MgO, magnesium, aluminum oxide, graphite, etc., we tell them to simply reread issue #89 then realize the situation has worsened significantly since that issue was published in September.

Regarding SiC, the September feature focused on what amounted to six reasons that global supply was in duress and why prices were increasing seemingly with each passing day.

Issue #89 cited the Chinese environmental police either curtailing or shutting down polluters; another factor was global inventory levels had been depleted due to the COVID-19 epidemic; a third reason was the cost of energy across the entire SiC landscape had either increased in price or was in short supply or both; the cost of both anthracite and petroleum coke on a worldwide scale were increasing in price with each tender; the global supply chain was broken due to the effects of COVID-19; and the sixth reason SiC was in duress and prices spiking was that FeSi pricing had ballooned to as high as $1.90# contained.

Here we are about six weeks after issue #89 was released and the situation is much worse. The above six factors are still in play except the circumstances have not improved but rather worsened and in several cases deteriorated significantly.

In particular, since September, the "Olympic Blue Sky" policy along with general efforts to control pollution have led to additional SiC furnace plant closings in China. Energy continues to increase in price and virtually all Chinese provinces with heavy kWh consuming industries have either closed or curtailed additional smelters. The price of both anthracite and pet coke continue to increase and both products are becoming more difficult to procure. The wild card – the price of FeSi – has pushed demand for SiC to new levels. When FeSi reached $1.90# contained many traders, producers, and consumers believed the price could go over $2.00# but virtually no one expected prices for 75% FeSi to hit $3.00# contained. This sort of pricing encouraged steel mills from around the world producing high carbon steel to switch to SiC where pricing was barely over $1.00# contained. Quite simply, global demand for SiC exceeds supply by a long shot forcing prices to 10-year highs and some experts believe by the end of 2021 prices on all grades of SiC will hit historical highs.

A processor commented, "I told an end-user that called for pricing that price was no longer the issue but rather supply going forward was going to be our concern."

Vessels carrying SiC – and other commodities – that should have left China in August, September or October are leaving ports in November and/or December. Vessels that had been scheduled to load in November and December 2021 are being canceled with prices on both the cargo and freight being renegotiated at higher levels.

One trader told ***SiC & More***, "I am hoping for clarity regarding supply for 2022 after the Olympics and Chinese New Year are in the rear-view mirror but that won't be until late February or possibly March. What happens between now and then is total guesswork, but I am certain prices on material and freight will increase again on January 1. I anticipate that not everyone will be able to secure the material they need whether it's silicon carbide or some other commodity."

A processor was quoted in ***SiC & More*** issue #89; "Yes, it's a perfect storm and I suspect the question will not be price but whether there is supply."

SiC prices are certain to increase and it appears as if all SiC end-use markets will feel the pain of higher prices throughout the entire 2022 calendar year.

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M&A ACTION INCREASING FOR BATTERY METALS

By Paul Harris



Pictured above is the Millennial Lithium facility

Lithium, Nickel, Cobalt, and Copper seem to suck the air out of the EV battery raw material discussion. However, the following demand forecast for critical battery raw materials depicts a slightly different way of looking at the key materials. In issue #91 of ***SiC & More***, a key global producer of spherical graphite from outside of China will be featured with Paul Harris once again wielding his mighty pen.

A fuse has been lit under mergers and acquisitions in the battery metal space as increasing prices for lithium, nickel and cobalt indicate that the penny has dropped on how few projects there are with which to meet growing demand from decarbonisation. This scarcity is leading to bidding wars.

In Argentina, Lithium America's just bid C$400 million for Millennial Lithium which controls the US$448 million Pastos Grandes project in Salta beating out the world's largest electric vehicles battery maker, Contemporary Amperex Technology (CATL), which itself beat out a bid from China's Ganfeng.

The fight for Millennial comes in the wake of a A$4 billion merger of equals in April between Orocobre and Galaxy Resources whose combined production could increase from around 40,000 tonnes per annum of lithium carbonate equivalent today to more than 100,000tpa in the near term.

In Canada, a similar battle is raging to take out nickel junior Noront Resources, pitting some of the world's biggest mining names against each other in the shape of BHP, the world's largest diversified miner, again Wyloo Metals, a vehicle of Andrew Forrest, owner of another Australian mining powerhouse, Fortescue Mining.

Meanwhile, South Africa's Sibanye-Stillwater has made a clear pivot into the battery metal space, a logical extension of its platinum group metals business which already supplies the auto catalytic convertor market. Sibanye's spending spree so far this year includes a 12,000tpy nickel processing plant in Le Havre in France for €65 million, an investment in the Keliber lithium hydroxide project in Finland, a joint venture with Ioneer to develop the Rhyolite Ridge lithium-boron project in Nevada, USA and most recently, a $1 billion deal to acquire producing nickel and copper mines in Brazil from Appian Capital Advisory.

"Given the lack of quality nickel sulphide production for battery use, we expect to see future consolidation within the nickel sector as larger players move to secure quality assets and add mine life to their portfolios," said Australia-based specialist funds management and corporate advisory firm Eden Partners in an August nickel update.

Nig miners and other investors are realizing that the *niche* battery metals are not going to remain niche in value terms for much longer. "They recognize these industries are a growth area, they are needed, they are sustainable and they are where the future is. ... A lot of junior companies are not well capitalized so that's an opportunity for the majors to bring their skills, their balance sheets and their credibility as auto and battery companies would rather deal with bigger, more established players," said RK Equity's Howard Klein.

Matt Fernley, editor of *Battery Materials Review* and research head of Westbeck Capital's Volta Energy Transition fund agrees. "It's only been with the growth in nickel and lithium prices that the big guys are starting to pay attention to the sector. ... I genuinely think that the prices have now gone up to a level where it's now justified to invest in new M&A."

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For Martin Turenne at FPX Nickel, the deals by BHP and Rio Tinto are the exception rather than the rule, standing-out due to their relative scarcity, as the majority of battery metals transactions have involved downstream companies from Asia even though the financial scale of the industries they belong to dwarfs the mining sector. “They are on the front lines of the raw materials procurement challenges. They know that in order to have a business, they're going to need these raw materials; it's existential to their business to have a secure supply of the metal units, and that is leading them to have the urgency to try to think about how they secure those metal units. Mining companies haven't yet displayed that same urgency. Developing a stable supply of North American nickel for the EV battery industry is an existential issue for the EV battery industry. It's not an existential issue for the mining companies,” Turenne told Mining Journal.

Despite the M&A headlines, capital is trickling into the battery metals sector. While the opportunities decarbonisation and the growth of electrification provide the minerals sector are significant, some question how realistic the sector’s ability to service the projected growth of EV’s and other decarbonisation applications is. “Anyone who looks at the demand implications from the current EV penetration forecasts will pretty rapidly come to the conclusion that the bottleneck is the fundamental supply of the raw materials and not just the refined materials, but the actual concentrates and other feedstocks that go into the refineries to produce the cathode materials for the batteries,” said FPX Nickel’s president and CEO Turenne.

Michael Scherb, founder and CEO of Appian Capital Advisory believes the penny is dropping if the recent sale of its Santa Rita and Serrote nickel and copper assets in Brazil to Sibanye Stillwater is any measure. “Nearly all the major mining houses were involved in this bid process. The bidders were a range of groups from all geographies, including China, North South America, UK, listed African players, all sizes, all backgrounds, so you had trading houses, you had major mining companies, you even had non-mining players, financial investors and car companies,” he told Mining Journal.

Progress at SUBLIME in South Africa:

SiC & More remains in contact with the Curimbaba Group regarding the restart of Sublime's #1 transformer group. Due to COVID-19, soft prices, and a tepid global SiC market, Sublime has been operating only transformer group #3, which yields about 18,000 metric tons per year and has been in a sold-out position for several years.

During an October 2020 interview with Leonardo Curimbaba (issue #84 of ***SiC & More***), Leonardo indicated that #1 would be restarted once the market began to support the additional tonnage. One year later, discussions with Leonardo regarding the restart of #1 include, "We are discussing this matter with the local electricity supplier, once we need their allowance to purchase more energy."

Without a doubt, Sublime's 1st transformer group is important to the global SiC landscape; perhaps never more important that it is today. Although the facility has seen more than its share of troubles over the past 10 years, the Curimbaba Group falls onto a short list of companies capable of expeditiously re-launching an idled transformer.

The 2nd transformer group at Sublime, however, is believed to be mothballed with virtually no chance of being restarted over the short or mid-term. The unit has not been repaired and brought back online since a fire damaged the transformer a number of years ago.

As stated in issue 84, an organization doesn't last 70 years without being resilient and battle-hardened. The Curimbaba Group has proven, that due to judicious ownership and acute business management, one can not only survive difficult times but grow and even prosper.

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NHQ PLOWS FORWARD DESPITE COVID-19



Pictured above is a section of the SiC laboratory at NHQ - Vietnam

In issue #88 of ***SiC & More***, we reported that Vietnam's only SiC furnace plant, New He Qiao Shareholdings Company's (NHQ), had planned upgrades to their SiC furnace groups located in Kinh Mon City, Vietnam.

The upgrades to transformer group No. 1 were completed during Q2 2021 with focus shifting to No. 2. The plan was to complete improvements to No. 2 before the end of 2022. However, the upgrades to No. 2 were postponed in June of 2021 due to a worsening COVID situation in Vietnam. As early as July 2021, COVID-19 infections in Vietnam were at a peak. The daily average was at its highest level since the pandemic began spreading across the globe.

Vietnam, as a country, has a rich history of successfully battling pandemics. For example, Vietnam was the second country after China to face SARS and was the first country declared SARS-free by the World Health Organization. According to *Examplars in Global Health*, "Many interventions pioneered by Vietnam during the SARS epidemic are being used to respond to COVID-19. Similarly, its experience with epidemic preparedness and response measure may have led to a greater willingness among people in the country to comply with a central public health response."

As of November 5, 2021, Vietnam's Ministry of Health confirmed a total of 946,043 cases of COVID-19 with 835,406 of the affected patients having recovered and released from hospitals. Vietnam also recorded 22,342 deaths due to the pandemic.

It's obvious why NHQ postponed the upgrade to No. 2 and It's also interesting to see how quickly Vietnam responded to the July outbreak and now, as a country, have the situation under control.

NHQ is currently operating at about 65% capacity utilization but plans to move closer to 100% during early 2022. As NHQ management puts it, "The capacity expansion is suspended by the epidemic but we are trying to improve productivity."

Energy remains in abundance but like virtually every other global SiC furnace operation kWh prices have increased. Management commented, "It has increased by 20% because Vietnam is buying electricity from China, now China is lacking power, it leads to the increase of Vietnam's energy." Besides kWh pricing, NHQ has seen both petroleum coke and anthracite spike in price. The response from NHQ management is an echo heard around the world, "The increase in price of anthracite is record breaking. Fortunately, we still have a considerable amount of carbon in our inventory and we are currently planning to purchase more for the coming year."

The price increases for energy and carbon source, however, have not deterred NHQ's efforts to maximize production. With global demand exceeding supply, it stands to reason that the world's SiC furnace plants would be smelting as much SiC as possible. Management said, "We used to avoid peak smelting to save the cost of power, with market going up, we will not avoid peak smelting to improve our productivity."

Like every other SiC producer, NHQ has been forced to increase prices on all grades of SiC to keep pace with the increases in the cost of energy and raw materials. NHQ increased prices on all grades for Q4

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2021 and expect to do the same during Q1 2022. NHQ currently enjoys a diverse market with 26% of shipments going to India; 25% to Korea; 24% to Japan; 10% to EU, and the balance to others including the U.S.

NHQ exceeded the expectations of many of the world's SiC experts going from a furnace plant that was initially designed to produce 12,000 m/t from Phase 1 in 2012 to a furnace plant that was capable of producing 50,000 m/t in 2019. When all of the upgrades are finally completed – going from 20,000 KVA to 40,000 KVA – NHQ will be one of the largest furnace plants in the world with over 80,000 m/t of annual capacity.

Of course, in the world of SiC, with growth comes additional environmental pressure. When asked about the environmental issues facing NHQ, ***SiC & More*** was told; Yes, we are also facing more and more strict environmental policies in Vietnam."

When asked about potential gas collection, "We are now in the phase of deciding on final design that conforms to China's standard. And will upgrade our environmental protection facilities by 2022." However, NHQ management also stated, "We are interested and are looking for better gas collection technology."

Since its commissioning in 2012, NHQ has incrementally added the ability to produce refractory and abrasive grains as well powders. Going forward, capital expenditures are mainly focused on continuing the march toward increased transformer capacity. Considering the current state of the global SiC industry, and the lack of reliable supply, NHQ's commitment to expanding the transformer thus furnace capacity of the facility is a badly needed development.

ELSID: A Bit Quiet in Romania

SiC & More has reported in the past that it is always a pleasure to hear from the somewhat mysterious but always interesting management team at ELSID Carbon Engineering. Eliciting information, however, out of ELSID is getting ever more difficult.

As reported in issue #86, depending on market demand, ELSID produces 28,000-40,000 metric tons per year of SiC and high-quality graphite with the option to increase production. Current capacity utilization is 70-80%.

Although information in March 2021 was vital to global SiC consumers, it has never been more important than it is right now. Global demand exceeds supply for a number of reasons and a SiC shortage the likes of which has not been seen in about 50 years is haunting the industry. Thus the impetus behind ***SiC & More*** pushing SiC producers for vital information.

The only information out of ELSID in recent months is that kWh pricing is a concern. That's not exactly big news since energy supply for most SiC furnace plants across the globe is more expensive today than in previous years and in some cases simply not available. Curtailments and shutdowns are not unusual.

SiC & More will continue to push ELSID for news since, in our view, they are one of the wild cards when it comes to global SiC supply. In addition, with graphite pricing also increasing at a rapid pace, ELSID's unused capacity (previously running at 70-80%) and ability to switch furnaces to either product, make them a target for badly needed supply.

During the interview with ELSID management for issue #86, ***SiC & More*** summarized the situation: It's always a pleasure to report on one of the world's leading producers of SiC, and as end-use markets across the globe seek to find alternatives to consumables produced in China, ELSID's presence becomes increasingly important.

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Talking Brazil and Energy

By: Francisco Batista

Spring in Brazil brought temporary relief in the drought situation with slightly above average rainfall in some of the hydro's reservoirs of the south and southeast regions. October is historically a month when most of the major hydros' reservoirs still lose capacity so the rain performed along with 20GW+ of thermal dispatch have actually helped recover 1.5% (from 16.7% - 09/30 to 18,2% - 10/31) of the reservoirs of the southeast of Brazil (responsible for about 75% of all water accumulation in the country to produce electricity).

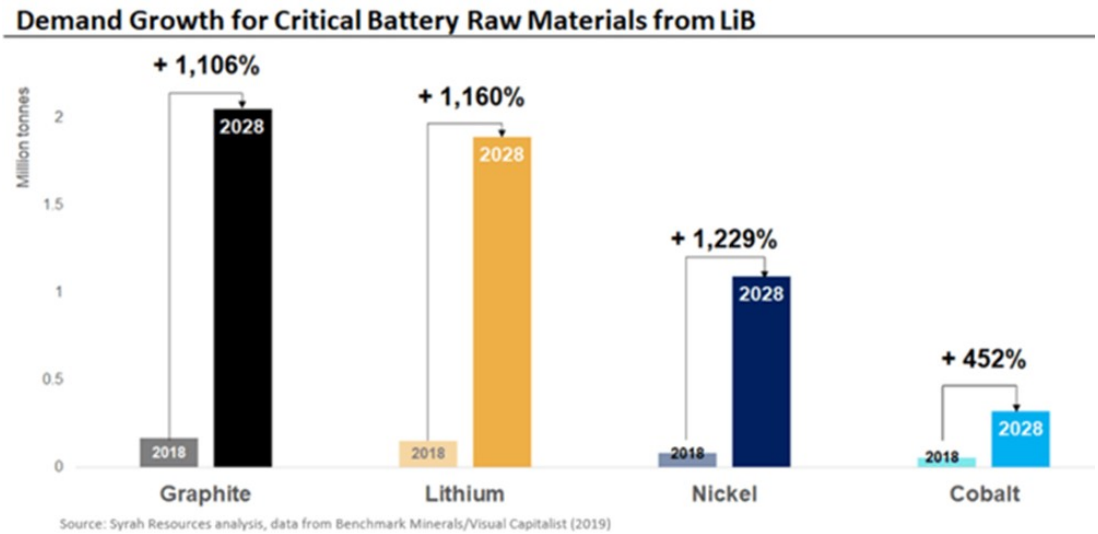
This bit of relief dropped the energy spot price from $100/MWh (09/15) to $20/MWh (10/31). The reason for this large decrease is due to the fact that the Brazilian energy system is priced under the marginal cost of operation method, which works greatly in parts of US, UK and other countries with high share of cheap thermal in the energy matrix. However, since Brasil has 70%+ of hydros and very few and expensive natural-gas/coal thermals, this pricing methodology produces discrepancies every time rainfall underperforms during rainy season (summers and autumn - period when reservoirs are set up to recover capacity) or overperforms during dry season (winter and spring - period when reservoirs are set up to lose capacity).

The current low spot price is neither a sign of long-term relief nor a reflection of the real status of the system. BR authorities are keeping every incentive to increase energy output from every source other than hydro, to reduce energy demand during peak-hours and to reduce residential consumption by overpaying premiums. The cost of the thermal dispatch is piling up and being funded partially by consumers and partially by the federal government which means the problem is far from being solved. On top of that, the wind energy season is over meaning a decrease in output from 12GW+ (June - Sept) to 4GW (Oct – May).

The next rainy season starts in December and lasts until the end of April. That's when reservoirs are set up to recover capacity as much as possible. Historically, when reservoirs reach 60% of capacity by the end of the rainy season it means spot prices extremely low ($25/MWh) for the remaining of the year, however, it is almost impossible to imagine this happening anytime in the next couple of years given the current levels.

We are now realistically looking for 75% of average rainfall in the next season to avoid a mandatory energy rationing in 2022. However, even if rain comes close to or is above average, the recovery in the reservoir levels will not be enough to shut down all thermal plants. As a result, spot prices may be reduced to $50/MWh but the other costs related to keeping these thermals in operation will make energy consumption in BR way more expensive throughout 2022 with potential reflections in 2023. Needless to say, the La Niña effect, which is already effective, might deteriorate these assumptions and jeopardize the whole plan.

Source: Syrah Resources (Courtesy Benchmark Minerals - 2019)



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BFA SUPPLY & PRICING ANGST



Ladles of BFA cooling

The supply situation in China continues to be perplexing to anyone buying a wide range of products from toys to steel and from apparel to brown fused aluminum oxide (BFA).

No doubt, as we have pointed out on numerous occasions over the years, high energy consuming industries that tend to obscure the air with both visible and invisible pollution are the targets for curtailment or shutdown when the "heating season" or Olympics arrive on the scene. How does this relate to BFA?

During Q1 2021 when many other commodities were experiencing a full steam ahead pricing angst, BFA prices were flat. In issue #87 (March), however, a trader told ***SiC & More,*** "This could be the lull before the storm. I suspect that is one reason that many processors in North America, Korea, and Japan have been ordering extra parcels. Prices could spike or even take a significant drop as we draw closer to winter. The price direction depends ono a number of variables including the environmental shutdown, currency devaluation, and worldwide economic recovery."

March and April did, in fact, represent a lull before the storm. The May and June BFA price increases were complimented by another $60-100 m/t increase during July and August. During September there was another $20-40 m/t hit. These price increases were across the board impacting BFA crude as well as refractory and abrasive grains.

SiC & More also reported in issue #89 that BFA was in short supply in China. It was also reported that due to some operational issues at several large smelters in Henan, along with a shortage of bauxite, prices would increase again during Q4 2021. Bauxite has become increasingly more expensive as inflated calcining costs are passed on to the BFA smelters. BFA, like many other commodities that consume large amounts of energy and emit off-gases and dust, have always been under scrutiny from the respective province's environmental authorities creating additional issues for smelter.

The situation has gone from bad to worse. There are nearly 60 sizeable aluminum oxide (AO) smelting (furnacing) plants in China with the most tonnage coming out of Henan Province. According to sources, less than 25 facilities are currently producing AO and none of them are running over 80% capacity with the majority of them operating at 50%. Henan AO producers have, for all practical purposes, been shut down.

SiC & More asked a processor of BFA crude what to expect going forward; "It appears as if parcels we expected would ship during December are postponed and even possibly cancelled. The prices being quoted are over $1,000 ton delivered to the states or Europe. The price is bad enough, having increased nearly $250 ton just since August, but to lose supply is a totally new and unacceptable situation."

During September (issue #89) we reported that a processor had said, "Prices are going to increase during the fourth quarter of 2021 and I even expect supply issues. We are buying as far ahead as we can to ensure supply. I anticipate that our customers will see price increases during the balance of 2021 and throughout 2022."

Apparently, the processors of crude in the EU and U.S. have their eye on the market because prices are increasing and supply is dwindling. What should BFA consumers expect as we move forward?

Pricing on parcels leaving China during January and February will reflect additional pricing angst and supply will be extremely tight until Q2 2022.

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Metals Industry Update

Global Steel

Production continues to decline in China having dropped by over 8% in September. The worldwide production dropped from 4.980 million tons per day in August to 4.814 million in September; 3.3% drop. Regardless of the recent slide in global production, the year-to-date daily average of 5.34 million tons represent a record.

Trade Gap

Setting a new all-time high for the second month in a row, the gap between U.S. exports and imports grew by 11.2% in September. The trade deficit hit $80.9 billion in September, which was an increase of $8.1 billion compared to August.

Rivian

Amazon recently placed the largest order for electric vehicles (EV) in history with a pledge to purchase 100,000 electric delivery vans. Rivian has raised more than $10 billion in funding since 2009.

John Deere

JD recently announced that the company had made an equity investment in ClearFlame Engine Technologies. ClearFlame is a start-up committed to the development of clean engine technology.

Komatsu

Komatsu reported six-month sales of $11.7 billion, which is up 34.8% from the first six months of 2020. Profits were reported at about $1.2 billion. Komatsu is riding the wave of strong demand for both construction and mining equipment.

TESLA



Tesla, Inc. reached an annual production rate of 1 million units for the first time late in the 3rd quarter. The company reported operating margins of nearly 15%, which is about three points higher than in the spring of this year. During early 2022, the company expects to bring to market their first EV's with the powerful 4680 battery cells. That technology is being tested now and thus far meeting expectations.

Lithium Carbonate

Lithium carbonate prices are presently at all-time highs and set to continue on their upward trajectory as demand continues to outstrip supply. Battery makers appear set to pass on lithium price increases to the automotive OEMs and other downstream customers which could have a major impact on electric vehicles coming to market between 2022 and 2024. Source: Battery Metals Digest

Iron Ore Prices

Spot iron ore prices were at $113-114 metric ton first week of November. In issue #88 (July) we reported that iron ore had hit a range of $215-219 m/t after increasing from the $170-172 m/t we had reported in issue #87. In August of 2020 iron ore was trading in the range of $119-121 m/t. This has been quite a year-long wild ride.

Stellantis / Samsung

South Korean batter maker Samsung SDI will join Stellantis in the production of EV batteries. The joint venture intends to begin production during 2025 and supply Stellantis auto factories in Canada, Mexico, and the U.S. Stellantis make popular U.S. brands including Jeep, Chrysler, and Ram and owns Peugeot, Fiat, Opel, Citroen, and Alfa Romeo.

Petmin

The South African based company has announced the restart of the $474 million Petmin USA pig iron plant in Ashtabula, Ohio. We last mentioned Petmin in issue #77 of ***SiC & More*** when the company announced plans to build the 425,000 ton per year nodular pig iron plant. Petmin temporarily halted the project during the COVID-19 pandemic but has recently announced the restart and has already invested more than $60 million in construction activities.

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DIGGING THROUGH THE ARCHIVES

This is the tenth segment from the incredibly dusty but irreplaceable ***SiC & More*** archives. The initial eight segments were focused on abrasives-related topis and, due to popular demand, the ninth issue as well as the next few releases of ***SiC & More*** will emphasize the nuances of silicon carbide (SiC) in the production of refractories. All ten segments are from a paper that we uncovered that does not bear the name of the author.

In issue #89 we left off with a paragraph on *Thermal Expansion* and we pick up issue #90 with the topic of *Hot Strength.*

Hot Strength: The pyrometric cone equivalent of high-grade silicon carbide refractories runs from Cone 37 to Cone 40. The module of rupture ranges from 800 to 3125 pounds per square inch at 1,350 degrees C and the crushing strength is generally above 10,000 pounds per square inch at this temperature.

The high temperature load test is frequently applied to evaluate refractories. The brick is subjected to a steady increase in temperature while under constant load and any change in height during the period the temperature is rising, is noted. The curve obtained from such a test is similar in shape to the thermal expansion curve where no load is applied. Such tests show that silicon carbide refractories have good resistance to deformation at high temperatures even under load. Reheat tests without load show no contraction after five hours at 1600 degrees C.

Resistance to Thermal Shock: The test for thermal shock resistance comprises subjecting the refractory shape to repeated heating and cooling. Cracks are developed in the refractory under the stresses caused by this treatment and large pieces will eventually chip off. This effect is called "spalling". Silicon carbide refractories will run through a far greater number of heating and cooling cycles than most other types before suffering any damage from spalling.

Resistance to Oxidation: While primarily a chemical property, resistance to oxidation is of importance in many refractory applications. Under oxidizing conditions a layer of silica will form about the silicon carbide grains and if the condition persists the refractory shape may swell and even fail eventually due to cracking, but the rate at which this oxidation takes place is so slow that economic life of the article is obtained. Work by A.C. Lee shows that oxidation rate is affected by porosity, grain size, bond adherence, and furnace atmosphere. He gives data showing the effect of these conditions. By controlling the condition and using the newer bonding materials which have been developed, the oxidation problem can be substantially overcome. This development, together with its chemical stability and the properties enumerated above, make it apparent that silicon carbide is an excellent material for the manufacture of refractories and a large tonnage is used every year for this purpose.

In issue #91 SiC & More will continue with the refractory segment with emphasis on *Applications* and *Refractory Cements*.

Silicon Carbide & More

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